

DEPARTMENT OF TRANSPORTATION**ENGINEERING SERVICE CENTER****Transportation Laboratory****5900 Folsom Blvd.****Sacramento, California 95819-4612****METHOD OF TEST FOR CHORD MODULUS OF ELASTICITY OF CONCRETE
(Compressometer Method)**

CAUTION: Prior to handling test materials, performing equipment setups, and/or conducting this method, testers are required to read **"SAFETY AND HEALTH"** in Section H of this method. It is the responsibility of whoever uses this method to consult and use departmental safety and health practices and determine the applicability of regulatory limitations before any testing is performed. Users of this method do so at their own risk.

A. SCOPE

The procedure used in determining the modulus of elasticity of concrete by means of a compressometer is described in this test method. Alternate methods using a dial gauge capable of reading to 0.0025 mm or an electronic recorder for plotting a stress-strain curve are described.

B. APPARATUS

The apparatus shall consist of the following:

1. Testing Machine:

Any type of testing machine capable of imposing a load at a constant rate of 0.25 ± 0.05 MPa per second if hydraulically operated. If a screw-type machine is used, the moving head shall travel at a rate of 1.25 mm per minute, when the machine is running idle. The machine shall conform to Section 15 of ASTM E-4, Methods of Verification of Testing Machines. The spherical head and bearing blocks shall conform to Section 2 of ASTM C-39, Method of Test for Compressive Strength of Molded Concrete Cylinders.

2. Compressometer:

The compressometer shall be capable of reading deformations to 0.0025 mm by means of a dial gauge, or by use of a linear variable differential transformer (LVDT) directly connected to a plotting recorder.

C. TEST RECORD FORM

Record the concrete test data and the deformation readings from a dial compressometer on a suitable form. If an LVDT and chart recorder are used, attach the plots to a form containing the concrete test data for the files.

D. TEST SPECIMENS

Mold and cap the test cylinders in accordance with the requirements for compression test specimens in ASTM C-192, "Method of Making and Curing Concrete Test Specimens in the Laboratory" or in accordance with California Test 540, "Method of Making and Curing Concrete Compressive Test Specimens in the Field." Subject the test cylinders to a specified curing condition and test at the age for which the elastic deformation information is desired. Test the cylinders in a moist condition after being removed from the curing room, unless another condition is specified.

E. TEST PROCEDURE

1. Maintain the ambient temperature and humidity as constant as possible throughout the test. Record any unusual fluctuation in temperature or humidity in the report.
2. If companion specimens are available, determine the compressive strength in accordance with ASTM C-39 prior to the test for modulus of elasticity.

3. Place the specimen, with the strain measuring equipment attached, on the lower platen or bearing block of the testing machine. Carefully align the axis of the specimen with the center of thrust of the spherically seated upper bearing block. Note the reading on the strain indicators. As the spherically seated block is brought slowly to bear upon the specimen, rotate the moveable portion of the block gently by hand so that uniform seating is obtained.
4. Pre-load the specimen to a stress at least equal to that to be used during the test, but not to exceed 75% of the ultimate strength of the specimen. Do not record any data during this pre-loading as the pre-loading is primarily for the seating of the gauges, etc., but merely observe the performance of the gauges and correct any unusual behavior prior to the second loading. If excessive correction is necessary, pre-load the specimen again prior to obtaining the deformation readings. At least two subsequent loadings during which the deformations are recorded are recommended so that the repeatability of the test may be noted.
5. Observe each set of readings as follows: Apply the load continuously and without shock. Apply the load at the rate specified in B-1. Record, without interruption of loading, the applied load and the longitudinal strain at pre-designated intervals. Position these intervals to obtain readings at sufficient points to permit plotting a stress strain curve if desired. Include in these readings (1) the applied load when the longitudinal strain is 50×10^{-6} m/m and (2) the longitudinal strain when the applied load is equal to 40 percent of the ultimate. The longitudinal strain is defined as the total longitudinal deformation divided by the effective gauge length.
6. If a dial indicator is used, plot the results of each test with the longitudinal strain as the abscissa and the compressive stress as the ordinate.
7. If a linear variable differential transformer (LVDT) and chart recorder are used in lieu of the dial gauge, check to be sure the correct amplification of the recorder drive is used to correspond with the testing range used on the testing machine. (Consult the instructions for proper operation of the recording device.)

F. CALCULATIONS

1. Calculate the chord modulus of elasticity, to the nearest 100 MPa, as follows:

$$E = (S_2 - S_1) / (C - 0.00005)$$

Where:

E = Chord modulus of elasticity in MPa.

S₂ = Stress corresponding to 40% of ultimate load.

S₁ = Stress corresponding to a longitudinal strain of 50×10^{-6} m/m .

C = Longitudinal strain produced by stress S₂.

G. PRECAUTIONS

1. The dial indicator on some compressometers indicates two times the actual deformation.
2. Strain recorder must be operated at the correct amplification of the recorder drive for the testing range being used for the testing machine in order to obtain a correct chart plot for the stress-strain relationship of the specimen.
3. Operation of the strain recorder should be checked before starting a modulus determination.

H. SAFETY AND HEALTH

Prior to handling, testing or disposing of any waste materials, testers are required to read: Part A (Section 5.0), Part B (Sections: 5.0, 6.0 and 10.0) and Part C (Section 1.0) of Caltrans Laboratory Safety Manual. Users of this method do so at their own risk.

REFERENCES:

California Test 540

ASTM Methods E-4, C-39, and C-192

End of Text (California Test 522 contains 2 Pages)